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September 10, 2010

MEMORANDUM

SUBJECT: Implications of Pond Containment Failures and Risks from Discharge of St. Louis Tunnel Treatment Ponds

FROM: Dan Wall, EPA Toxicologist

TO: Steven Way, EPA On-Scene Coordinator

IMPLICATIONS OF TREATMENT POND FAILURES

The St. Louis Tunnel (SLT) Passive Treatment system sits adjacent to the Dolores River. The treatment system is a series of ponds that are designed to precipitate metals emanating from SLT drainage and as a consequence the sediments from the treatment ponds have become highly contaminated with a variety of metals. Sediment core samples were collected from Ponds 5, 9, 11, and 18, and analyses of these core samples and of sediment samples collected in 2000 and 2003 reveal a roughly uniform composition of metals throughout the pond sludges at depth. The sediments all contain concentrations of Zinc ranging from 18,000 to 37,700 ppm, Cadmium ranging from 51.4 to 190 ppm, Copper ranging from 650 to 2460 ppm, and Lead ranging from 200 ppm to 957 ppm. The following is a discussion of the ecological implications of a treatment pond(s) failing to contain the sediments and releasing them to the Dolores River.

The assessment of the potential toxicity of sediments based on bulk metals concentrations is an imprecise endeavor without additional supporting information. The best available approach for this type of comparison is to compare benchmarks developed in the consensus-based sediment quality guidelines for freshwater ecosystems document (MacDonald et al, 2000) to sediment concentrations. The benchmarks developed in this document include a Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC). Concentrations below the TEC are considered to be protective of aquatic invertebrate and have been shown to be accurate in at least 72% of the metals contaminated sediments tested. Concentrations above the PEC are considered likely to harm organisms and have been shown to accurately predict toxicity in at least 75% of the tested sediments.

As can be seen in the following table the concentrations of contaminants in the sediments greatly exceed the higher PEC benchmark value with cadmium and zinc exceeding PEC values by up to 2 orders of magnitude. Despite the difficulties associated with assessing the potential toxicity of sediments it is almost a certainty that if treatment pond sediments were released to the Dolores River in sufficient quantity they would be toxic to aquatic invertebrates.

Metal	TEC (ppm)	PEC (ppm)	Sediment Concentration Range (ppm)
Cadmium	1	5	51.4 - 190
Copper	32	149	650 - 2460

Lead	36	128	200 - 957
Zinc	121	459	18,000 – 37,700

The effects would likely run a continuum of severe impacts near the site to minor impacts at some downstream location. The footprint of sediment deposition would be the most severely impacted based on both the physical and chemical effects on the stream bed. Areas inundated with contaminated sediments would eliminate virtually all benthic invertebrate habitat by filling in spaces in the cobble that are needed by most resident insects to survive and by fish to reproduce. Immediate chemical impacts to downstream aquatic populations would likely be observed as a pulse of high metals concentrations released with and from the tailings. Fish kills would be probable. For some extended period of time after the failure, metals from the released sediments would be leached into the stream and would likely produce localized areas of lethal concentrations of metals. Gradually the leachable metals would be depleted and areas that weren't inundated with sediments would begin to recover.

RISKS FROM EXISTING DISCHARGE

The State of Colorado developed a Water Quality Assessment (WQA) for the Mainstem of the Dolores River in October 20008. The WQA proposed monthly chronic and acute WQBELS (water quality based effluent limits) for the protection of the Dolores River. Additionally, as part of the WQA acute and chronic low flow conditions were calculated for the Dolores River. These values, in conjunction with the available analytical results were used to calculate concentrations of metals in the Dolores River under a variety of flow and discharge scenarios.

The predicted concentrations of zinc and cadmium in the Dolores River ranged from 790-1220 ug/l and 3.76-6.53 ug/l, respectively. The acute/chronic water quality standards for zinc and cadmium calculated in the WQA based on a hardness of 247mg/l are 301/269 ug/l and 3.74/0.84 ug/l, respectively. This memo does not address the validity of these calculations and predictions but is limited to providing an opinion on whether the predicted concentrations in the Dolores River pose a risk to fish populations.

Based on these predicted concentrations of zinc in the Dolores River, I would anticipate mortality to occur to trout during their sensitive life stages (i.e. swim-up fry). This is based on 2 lines of evidence.

The first is line of evidence is from results of reference toxicity testing conducted at the EPA Golden Laboratory (Figure 3.3-2). These results are conducted as a positive control with each toxicity test that is conducted with site water. Reference tests are run with rainbow trout using reconstituted laboratory water spiked with zinc as the toxicant. The results of 7 tests conducted since 2005 yield a mean LC50 of 260 ug/l dissolved zinc at a hardness of about 90 mg/l. which translates to 612 ug/l dissolved zinc at a hardness of 247mg/l. These results are presented below. The concentrations predicted to occur in the Dolores River exceed this LC50 value and therefore I would anticipate that if the predicted concentrations were to occur in the river, mortality of sensitive trout life stages would occur. Reliance on laboratory toxicity tests is uncertain due to site specific conditions which may mitigate or exacerbate toxicity.

The second line of evidence is based on EPA (2006) investigations of the toxicity of zinc to brown trout, using both site (Upper Arkansas River) and laboratory waters. The goal of the study was to develop an exposure-response model for brown trout exposed to zinc under a variety of conditions. Five toxicity tests were run including 2 on-site dilution studies, 2 laboratory studies (conducted by Colorado Division of

Wildlife) and an on-site water spiking study. The results led to a model that reliably predicts the percent mortality based on the zinc concentration and hardness. This model is specific to the Upper Arkansas but as is seen in figure 4-2 below, there is good agreement between the laboratory and field results. Using the range of zinc concentrations predicted to occur in the Dolores River under the various scenarios (790-1220 ug/l), the model predicts between 4 and 10% mortality of brown trout at their sensitive life stage.

If the current trends continue and the concentrations of zinc in the outfall approach adit concentrations, the predicted concentrations of zinc in the river are from 1052-1628 ug/L under different low flow conditions. The model predicts between 7 and 17 % mortality of brown trout at their sensitive life stage under these scenarios.

This line of evidence likely predicts less toxicity to brown trout than the reference testing because of several factors, including species differences, use of site water and differences between testing laboratories. Additionally, it is not possible with the available information to determine the distance that the concentrations of zinc would be present at levels that pose risk to fish populations or whether sensitive life stages would be present in this reach of the river.

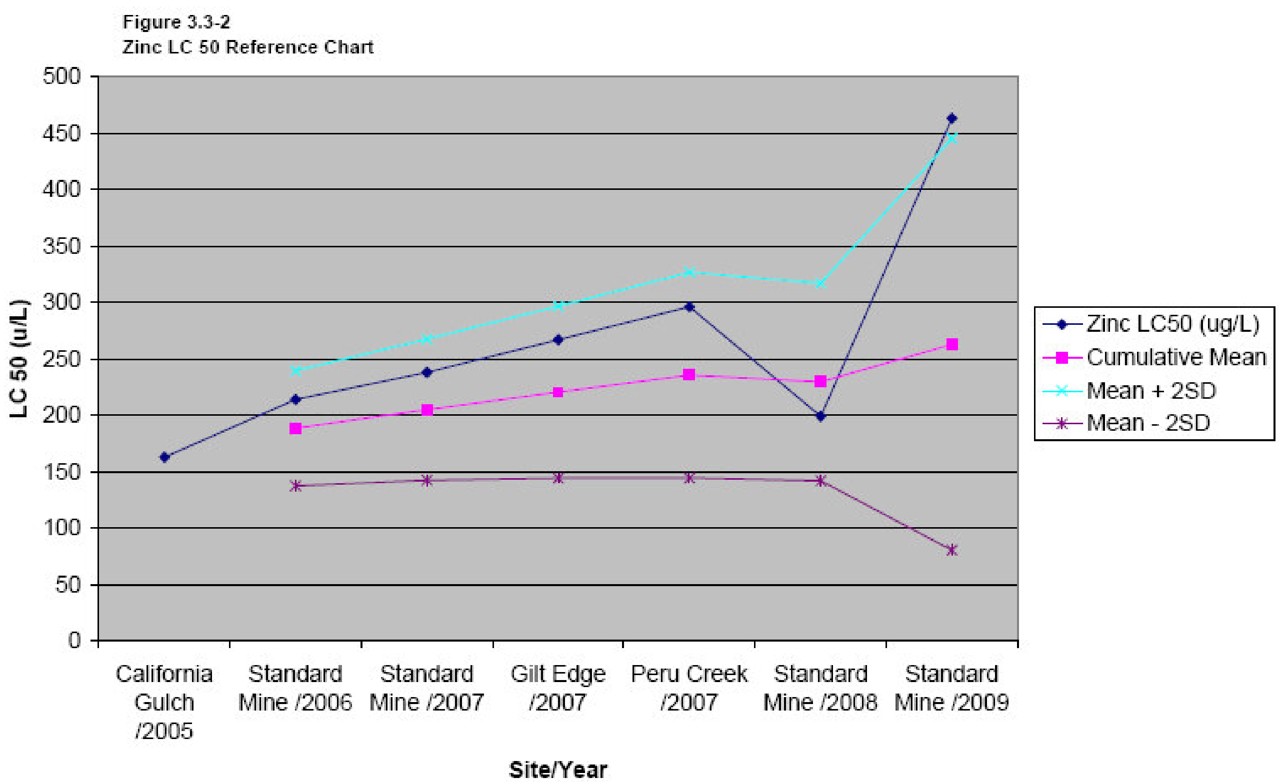
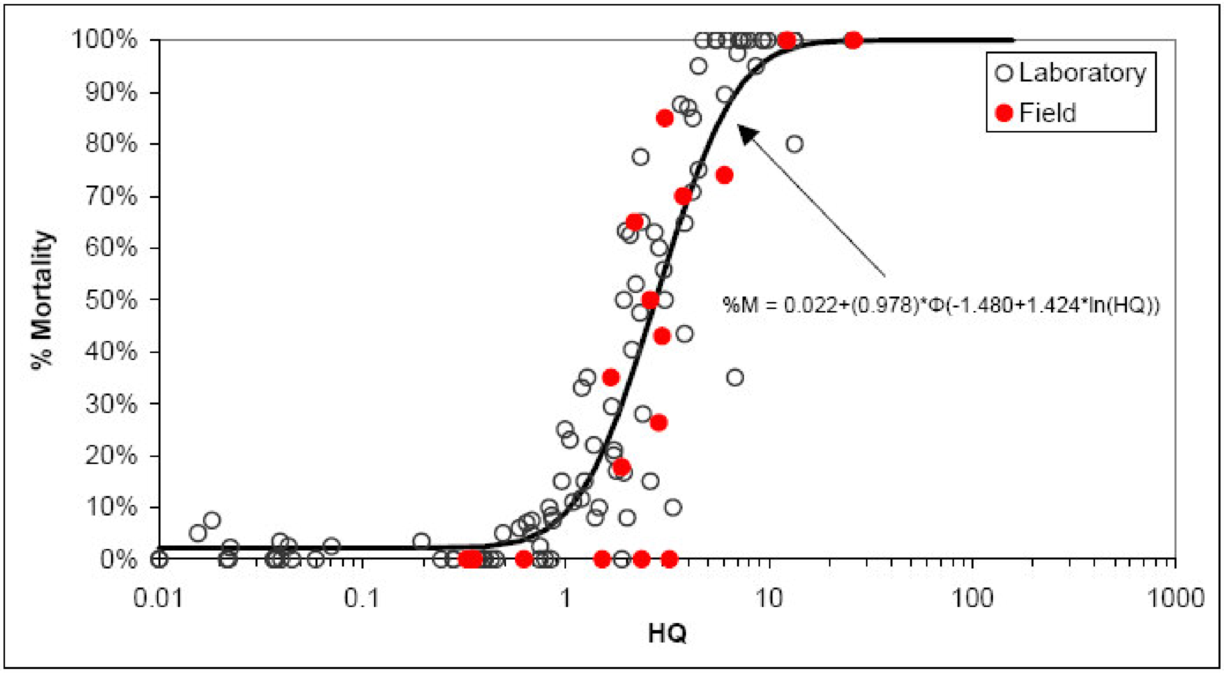


Figure 4-2. Comparison of All Laboratory and Field Studies



MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

EPA, 2006. Laboratory and Field Investigations of Zinc Toxicity on Brown Trout in the Upper Arkansas River.